REMARKS

Applicants have amended Claim 1 to more clearly define the invention. Support for the amendment can be found at page 6, lines 12-14 of the present specification. Claim 4 has been canceled.

Claim 1 stands rejected under 35 U.S.C. 102(b) as anticipated by U.S. Patent 5,962,169 to Angell, et al. According to the Examiner, '169 shows ionic compounds incorporated into rubber systems and mentions liquid ionic compound. Applicants respectfully disagree with the interpretation of the reference and conclusion regarding patentability. In applicant's view, Angell does not teach, disclose or suggest the use of an "ionic liquid" as taught in the present invention. Nor does Angell teach the use of rubber.

An object of the present invention is to provide a moderately resistive rubber composition or rubber member which can reliably attain a target resistance. The resulting resistance of the rubber composition depends upon the method of addition and the materials used.

To accomplish these objectives, the present invention teaches the use of an "ionic liquid," which serves as an electrically conductive material, which is then added to rubber. In contrast, Angell teaches commonly employed "ion conductors." Ion conductors are distinctly different from the "ionic liquid" taught in the present invention. Although Angell mentions the words "ionic liquid" at column 4, line 62, this reference is distinguishable from the usage in the present invention. This distinction is critical and is discussed in detail with a focus on general knowledge of one skilled in the art, comparative examples contained within the present specification and the distinctions between the present invention and Angell.

An "ionic liquid" is very different to an ion conductor especially when working with rubber and when a certain electrical resistance level is desired in a rubber composition or molded rubber product. Simply adding a conductive material to rubber to make the rubber electrically conductive is a well-known technique. If an ordinary ionic conductor is added, such an addition will surely impart electrical conductivity to rubber. However, electrical resistance will vary greatly in response to change in temperature, humidity, and applied voltage. (See for example Specification at page 2, line 23 through page 3, line 2)

In contrast, since humidity dependence of an ionic liquid is small, variation in electrical resistance attributable to the temperature, humidity, or applied voltage is

also small. Therefore, desired electrical conductivity can be consistently obtained. Furthermore, not only does the addition of an ionic liquid result in different physical properties but an ionic liquid is in liquid state at room temperature which further enhances the ability to reliably attain a certain resistance in the resulting rubber composition or member.

This effect on electrical resistance by the addition of an ion conductor is well know by those skilled in the art. When an ordinary ion conductor is added to a polymer compound, electrical conductivity is obtained. However, if the amount of addition surpasses a certain level, electrical conductivity decreases. This well-known phenomenon is believed to be attributed to restricted movement of polymer chain segments, which results from an increase in the number of coordinate bonds between cations of the ion conductor and donor atoms (e.g., ether oxygen) and hinders transfer of ion carriers. This phenomenon tells us that electrical conductivity can be imparted but with limits. This limitation poses a great barrier in the manufacture of desired electrically conductive parts.

In contrast, when an ionic liquid (which is in liquid form) is employed, a decrease in electrical conductivity will be prevented due to the limitation of coordinate bonds with donor atoms. In other words, by using an ionic liquid, electrical conductivity can be imparted in a range far broader than that attained by ordinary ion conductors. Thus, an ionic liquid has physical properties that are clearly distinguished from those of generally employed ion conductors.

The differences between an ionic liquid and an ion conductor are further substantiated and exemplified by the comparative tests included in the present specification. The comparative examples show the results obtained from addition of an "ionic compound" (which is <u>not</u> an "ionic liquid") to rubber and corresponding results obtained from addition of an "ionic liquid" to rubber. (See Comparative Examples 21 through 25 (uses sodium trifluoroacetate) and Comparative Example 28 (uses lithium perchlorate)). As the Examples show, the addition of ionic liquid reduces the resistance of the resultant rubber composition and a target resistance can be reliably attained.

As the present Examples show and as one skilled in the art can recognize, there are critical differences between an ionic liquid and an ion conductor. While the present invention teaches the use of ionic liquid, Angell teaches ion conductors. Specifically, Angell teaches adding a high molecular weight polymer to an ion

compound for use in electrolytic cells as primary and secondary batteries. More specifically, Angell teaches the use of several common polymers including polypropylene oxide (PPO), polyethylene oxide (PEO), and poly(bis(methoxyethoxy)ethoxy)phosphazine (MEEP). Importantly, Angell does not include any substances which are equivalent to rubber. Instead, Angell teaches liquid, rubbery solid alkali metal salts. The rubbery consistency is caused by the normal chain entanglement of a high molecular weight polymer. A rubbery consistency of a salt is very different than a rubber composition or molded product as taught in the instant invention.

The fact that Angell does not teach the use of rubber or equivalents is noteworthy. Not only is Angell's teachings outside the scope of the present invention but the process of imparting electrical conductivity to rubber is different than imparting electrical conductivity to an ordinary non-rubber polymer.

The routine practice of imparting electrical conductivity to an ordinary polymer, which is <u>not</u> a rubber, is physically blending a conductive material with the use of a solvent or melting under heat.

However, for imparting electrical conductivity to rubber, one must first add a conductive material, allow the cross-linking reaction to proceed and subsequently mold the desired product. In other words, when rubber is treated for introducing electrical conductivity, a cross-linking reaction is necessary after addition of conductive material. This means that the conductive material must be selected so as not to impede the cross-linking reaction and not to lose its inherent properties. Accordingly, rubber cannot be handled like ordinary polymers and Angell thus teaches away from the present invention.

Finally, in addition to the distinctions discussed above, Angell teaches a very different polymer content than the present invention. According to Angell, the polymer content is preferably not more than 40 weight percent. According to the present invention, as shown in the Examples section, ionic liquid is added in an amount of 0.1, 1, 5, 10, or 20 parts by weight to 100 parts by weight of rubber. The amount of addition of corresponding substances significantly differs between the two inventions.

This difference stems from the difference in technical concept or merits between the two inventions. That is, according to the present invention, in order to obtain desired electrical conductivity in a consistent manner, without permitting

problematic variation in electrical resistance attributable to temperature, humidity, or applied voltage, an ionic liquid which serves as an conductive material is added to rubber. In contrast and according to Angell, in order to produce a rubbery liquid electrolyte, a polymer is added to an ion conductor.

Therefore, Angell simply teaches a completely different invention and the distinctions between the use of an ionic liquid as opposed to an ion conductor are significant and support the novelty of the present invention.

Claims 1-6 stand rejected under 35 U.S.C 103(a) as unpatentable over U.S. Patent 6,810,225 to Kitano, et al. Claims 1-6 are also rejected in section 12 of the Office Action as unpatentable over Angell '169 or U.S. Patent 6,458,883 to Takashima, et al in view of U.S. Patent 6,841,304 to Michot, et al.

As discussed above, Angell does not teach the ionic liquid of the present invention and is silent about an "ionic liquid which is a molten salt and is in liquid form at ambient temperature." Therefore, Angell '169 fails as a primary reference. Kitano '225 or Takashima '883 cannot cure the deficiencies and thus fail alone or in combination as supporting references.

Kitano teaches adding an ionic compound to rubber. Takashima teaches adding a conductivity imparting agent to rubber. Neither of these two references disclose a substance which is equivalent to the "ionic liquid which is a molten salt and is in liquid form at ambient temperature" as taught and claimed in the present invention.

As described above, since an ionic liquid is a unique substance, it cannot be regarded in the same light as an ion conductor. Accordingly, the "ionic compound" of Kitano or the "conductivity imparting agent" of Takashima are not interchangeable with the ionic liquid of the present invention. One skilled in the art would simply not view these substances as equivalents or obvious variants of one another.

Finally, U.S. Patent 6,841,304 to Michot likewise fails as a secondary reference. Michot '304 merely describes a molten salt and electrolytic solutes prepared by use of the molten salt. Michot contains no description or suggestion and does not provide any motivation for adding such substances to rubber. The reference therefore fails.

In view of the above amendments and remarks, claims 1-3, 5 and 6 are considered to represent a novel and unobvious advance in the art. We believe that a prompt issuance of a Notice of Allowance for these claims is in order and such action is requested. If any issues remain outstanding, the Examiner is urged to contact the undersigned to expedite their resolution.

Respectfully submitted,

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